

Using of maple syrup as an alternative to sucrose and whey in making healthy functional sherbet-ice

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Abstract

The study was aimed to produce refreshing and healthy fat-free, low-calorie drinks by using acid whey as a basic material resulting from making cheese as an alternative to milk. Sugar has been replaced partially or completely with maple syrup at 0, 35, 70 and 100% and the chemical and physical tests of both blends were conducted. The level results showed a significant decrease in total solids, total sugars, viscosity, overrun, an increase in specific weight, and ash. The control treatment showed higher melting resistance than the rest of the treatments made with the replacement of sugar. Although the total acidity was lower than the comparison sample, the acidity of the maple syrup mixtures was observed to have significantly increased. The fat percentage was not affected by the addition of maple syrup and was not significant. Sensory evaluation showed that the 100% maple syrup sample received the highest sensory rating score.

1. Introduction

Large amounts of liquid waste, known as "cheese whey," are produced by food processing industries such as dairy and cheese processing plants (Mollea *et al.*, 2013). Whey is an acidic by-product produced during the manufacture of a range of dairy products, including yoghurts, fresh and soft cheeses such as cream cheeses (Wherry *et al.*, 2019). Whey is the liquid leftover after fat and casein have been removed from milk, and it contains mainly soluble components such as lactose, soluble salts, and globular proteins (Chandrapala *et al.*, 2016). Lactose, on the other hand, is the most abundant portion of whey (approximately 70% dry matter basis). After cheesemaking, the bulk of milk carbohydrates migrates through the whey, with lactose responsible for 90% of the amount, along with some glucose, galactose, oligosaccharides, and amino sugars (Božanić *et al.*, 2014). The European Union has the world's biggest cheese market, resulting in a significant supply of acid whey. The production of acid whey from cheese alone is projected to be 40 million tonnes a year in the European Union (Zotta *et al.*, 2020). Whey has many functions of glutamate and emulsification compared to other proteins (Daultani *et al.*, 2003). Whey's toxic consequences are the greatest problem.

Biochemical requirements for oxygen (BOD) are between 40,000 and 60,000 mg/L and chemical oxygen (COD) between 50,000 and 80 000 mg/L (Chatzipaschali

and Sattamis, 2012). Acid whey is distinguished by a high concentration of lactic acid and minerals, which makes industrial production impossible and restricts its food applications. Membrane approaches are used to solve these problems because the structure and properties of raw materials are easily manipulated. Demineralization of acid whey allows removing a significant part of mineral (50%) from it and providing the required acidity in the range, corresponding to raw milk (Evdokimov *et al.*, 2015). Whey protein helps promote weight loss, lower cholesterol, and lower blood pressure as a protein supplement, especially for people trying to develop muscles by exercising and eating whey protein powder (Patel, 2015).

In a study conducted, the water in the preparation of Egyptian Baladi, bread was replaced with sweet whey, as the whey improved the physical, chemical, and sensory properties of the bread, and the properties of the bread improved by increasing the substitution rate (Gaber *et al.*, 2017). In the study on the effects of replacing the skim milk with some dried fruit used in making ice cream, there was an increase in the total solids content, pH, specific weight, and viscosity of the resulting ice cream compared to the control sample (Hasan *et al.*, 2020). In a study, whey was prepared as a frozen dessert using pineapple fruit, and kiwi, the results attained a higher sensory score in colour, appearance, taste, and flavour as the frozen whey candy underwent a consumer

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adaptability study and it was found that 58%, of consumers, rated the candy as excellent (Chavan *et al.*, 2020). Maple syrup is usually made from boiling the maple trees, red maple, and black maple and is a natural sweetener that can be changed into sucrose due to its mineral content and high amount of phenolic compounds with vital activities such as antioxidant, antibacterial, and anti-cancer in addition to its content of calcium, iron and other compounds (Mellado-Mojica *et al.*, 2016).

The sap contains about 97% water and 3% solids, the solids are mainly sucrose sugar and small amounts of glucose and fructose. It takes forty litres of sap to produce one litre of maple syrup. The process is time and energy consuming (Aider *et al.*, 2007). Maple syrup is the largest natural product produced and consumed commercially and is obtained entirely from deciduous tree sap. It is produced by thermal evaporation of the colourless water sap collected from the maple species (Perkins and Van den Berg, 2009). Maple syrup is produced by concentrating maple tree sap. The physical-chemical features of maple syrup may be depending on the treatment method, microbial contamination, seasonal and geographical differences, minerals and phenolics in maple syrup may provide additional health benefits due to their vital activities (Nimalaratne *et al.*, 2020). It was found to have a strong effect on prostate and lung cancer cells. Another study showed that maple syrup possesses the ability to inhibit nitric oxide. Inhibition of nitric oxide leads to inhibition of inflammation, which may help in the prevention of cancer (Legault *et al.*, 2010).

The consumption of maple syrup has been shown to produce fewer responses to glucose and human insulin, compared to corn syrup, brown rice syrup, and dextrose, making it a better alternative to refined sugars in our diets (St-Pierre *et al.*, 2014). The objective of this study was to use whey protein as a basic material in the chilled drinking industry as it contains a good proportion of mineral salts, proteins, and dissolved vitamins in the water and the lactose, as well as to reduce wastage of whey protein of wastewater. Thus, reducing the proportion of pollution, of the use of the maple syrup as a sugar substitute, sweetener, and natural colourant to fortify the product, as the source is rich in minerals, including iron, zinc, and manganese, as well as a good source of antioxidants.

2. Materials and methods

2.1 Materials

Fresh whey was obtained from cheese making and used in sherbet-ice sugar. Whereas citric acid and Carboxy Methyl Cellulose (CMC) were purchased from the local market, while maple syrup was purchased from

the international market.

2.2 Preparation of sherbet-ice

Iced syrups (Sherbet-ice) made according to Salim (1986) were made with four treatments. Each treatment with an amount of 1 kg heated whey at 40°C and added the estimated amount of sugar of 20% after mixing it with the stabilizer. The dry materials were gradually added and mixed well to complete the melting with a continuous stirring at a temperature of 73°C for 15 s and cooling and a temperature of 5°C for a period ranging from 2-4 hrs. The prescribed proportion of maple syrup was added then froze and whisk for 10-13 mins. 250 mL plastic containers were then filled and transferred into the freezer for hardening at -18°C until further analysis. Table 1 shows the selected compositions for making sherbet-ice mix formulas and indicated that sugar was replaced by maple syrup at levels control (T), 35% (T1), 70% (T2), and 100% (T3).

Table 1. Formulations of Sherbet-ice mixes.

Ingredients/g	T	T1	T2	T3
Whey	800	800	800	800
Total sugar	200	130	60	---
Maple syrup	---	70	140	200
CMC	5	5	5	5
Citric acid	3	3	3	3
Total	1008	1008	1008	1008

2.3 Methods of analysis

Ash, total protein contents, titratable acidity and pH were determined according to AOAC (2012). The total sugars of the mixtures were calculated by the method of difference between the components as mentioned by Pearson (1996). The Kerber method was used to quantify the lipid in the mixtures according to Ling (1963). The viscosity was estimated using a US-made MODEL RVDVE (BROOKFIELD) device that works on the principle of converting friction into a viscosity reading. Melting resistance was determined according to Sofjan and Hartel (2004) and overrun was determined according to Laaman (2011).

2.4 Sensory evaluation

The sensory evaluation for the resultant sherbet-ice was carried out by 10 staff members of the dairy department, for flavour (50 points), texture (30 points), colour (10 points), and appearance (10 points).

2.5 Statistical analysis

Data were analysed according to a factor experiment system using the experiment conducted in C.R.D. The averages were tested by Duncan's multi-range test under a probability level of 0.05 as used the SAS Statistical

Analysis System program, using the computer to conduct statistical analysis of the data.

3. Results and discussion

3.1 Chemical tests

Table 2 displays the significant decrease in the total solids significantly ($p < 0.05$) and acidity when replaced with maple syrup, which was proportional to the rate of substitution. On the other hand, pH values tended to increase with the addition of maple syrup, results are in harmony with those obtained from Yazdanpanah (2020) when sugar was replaced with maple syrup in ice cream. The data indicated that fat was not significantly affected by the substitution even though there was a slight decrease. These results are in agreement with those obtained from Salama *et al.* (2016). Whereby, the protein content decreased as the maple syrup content increased because it contains a negligible amount of protein. The highest mean protein score was recorded in the control. Those results are in line with the findings of Rashid and Thakur (2012). The ash content of the mixes with a higher proportion of maple syrup increased significantly ($p < 0.05$), which is consistent with the findings of Farahat (2011) and Salama *et al.* (2016), who found that when

sugar was replaced with date syrup in ice cream production, the ash content increased significantly ($p < 0.05$).

3.2 Rheological properties

Table 3 shows the rheological properties of various materials as compared to the control, the specific gravity of sherbet ice with substituted sugar was higher. With an increase in the percentage of sugar substitution with maple syrup, these results were in harmony with those reported by Tammam *et al.* (2014). The viscosity levels decreased slightly ($p < 0.05$). The drop in viscosity ratios may be attributed to a reduction in total solids in iced beverages that use maple syrup instead of sugar. These observations are consistent with Salama *et al.* (2016). The overrun decreased as the substitution of maple syrup increased significantly compared with control. This decrease in overrun might happened due to the weak functional properties (whipping and foamability) of maple syrup. It was indicated that as specific gravity increased the overrun decreased (Tammam *et al.*, 2014).

3.3 Melting resistance

As seen in Table 4 the decreased melting resistance

Table 2. Effect of maple syrup on some properties of replaced sugar sherbet-ice.

Chemical tests	T	T1	T2	T3
Total solids	28.14±0.002 ^a	25.62±0.12 ^b	23.87±0.85 ^c	18.65±0.055 ^d
Total sugars	26.41±0.171 ^a	23.84±0.069 ^b	21.92±0.037 ^c	16.67±0.059 ^d
Fat	0.57±0.37 ^a	0.50±0.18 ^a	0.46±0.17 ^a	0.43±0.32 ^a
Acidity	0.53±0.057 ^a	0.42±0.00 ^d	0.44±0.037 ^c	0.46±0.025 ^b
PH	3.96±0.01 ^c	4.7±0.01 ^a	4.6±0.037 ^a	4.2±0.025 ^b
Protein	0.59±0.017 ^a	0.54±0.01 ^c	0.55±0.011 ^{bc}	0.51±0.022 ^d
Ash	0.58±0.01 ^d	0.74±0.015 ^c	0.93±0.037 ^b	1.06±0.025 ^a

Values are presented as mean±SD. Values with different superscript within the same row are significantly different ($P < 0.05$). T: control, T1: 35% sugar was replaced by maple syrup, T2: 70% sugar was replaced by maple syrup, and T3: 100% sugar was replaced by maple syrup.

Table 3. Effect of maple syrup on some rheological properties of replaced sugar sherbet-ice.

Rheological properties	T	T1	T2	T3
Specific weight	0.686±0.001 ^c	0.784±0.003 ^b	0.865±0.049 ^a	0.887±0.06 ^a
Viscosity	674.33±5.132 ^a	454.33±2.309 ^b	372.66± 2.517 ^c	322±1 ^d
Over run	54.70±1.009 ^a	40.91±0.395 ^b	31.48±0.769 ^c	23.36±0.230 ^d

Values are presented as mean±SD. Values with different superscript within the same row are significantly different ($P < 0.05$). T: control, T1: 35% sugar was replaced by maple syrup, T2: 70% sugar was replaced by maple syrup, and T3: 100% sugar was replaced by maple syrup.

Table 4. Effect of maple syrup on melting resistance of replaced sugar sherbet-ice.

Melting resistance	T	T1	T2	T3
30 min	5.63± 0.57 ^j	6.3±0.1 ⁱ	6.32±0.01 ⁱ	7.03±0.15 ^h
60 min	30.10±0.1 ^g	39.367±0.15 ^f	40.2±0.36 ^c	40.8±0.52 ^d
90 min	80.8±0.1 ^c	89.43±0.37 ^b	89.733±0.15 ^b	91.633±0.98 ^a

Values are presented as mean±SD. Values with different superscript within the same row are significantly different ($P < 0.05$). T: control, T1: 35% sugar was replaced by maple syrup, T2: 70% sugar was replaced by maple syrup, and T3: 100% sugar was replaced by maple syrup.

Table 5. Sensory evaluation of replacing sugar by maple syrup sherbet ice

Sensory evaluation	T	T1	T2	T3
Flavour 50	33±1.52 ^d	44±0.75 ^c	46±0.75 ^{ab}	47±0.57 ^a
Textures 30	24±0.57 ^c	24±1 ^c	25±0.75 ^b	27±0.57 ^a
Colour 10	4±0.57 ^c	6 ±0.57 ^b	6±0.75 ^b	9±0.57 ^a
Appearance 10	5±0.57 ^c	8±0.57 ^b	8±0.75 ^b	9±0.75 ^a

Values are presented as mean±SD. Values with different superscript within the same row are significantly different (P<0.05). T: control, T1: 35% sugar was replaced by maple syrup, T2: 70% sugar was replaced by maple syrup, and T3: 100% sugar was replaced by maple syrup.

of sherbet ice was proportional ($p < 0.05$) to the amount of maple syrup used. The melting resistance of sherbet ice was expressed as the loss in weight per cent of the initial weight of the tested formula within 90 min. The control treatment showed higher melting resistance than the rest made with the replacement of sugar. It was found that the melting resistance was related to the viscosity of the mix. These results are following those of El-Kholy (2005) and Salama *et al.* (2016). This may be due to their lower content of water holding constituents (Hassan, 2005). Generally, as the mix viscosity increased the resistance of ice milk to melting increase (Arbuckle, 1986; Salem *et al.*, 2003).

3.4 Sensory evaluation

Table 5 represents the sensory evaluation of the final product. The results obtained revealed that the replacement of sugar by maple syrup improved the taste body, texture, colour and overall liking scores significantly ($p < 0.05$), with maple syrup percentage while the control treatment was less liked due to the whey sour taste.

4. Conclusion

Iced drinks with high nutritional value, good physical and organoleptic properties can be successfully prepared by using whey and replacing sugar with maple syrup. The obtained products can be considered functional ice milk varieties.

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